A Community Terrain-Following Ocean Modeling System

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LONG-TERM GOALS

The long term goal is to design, to develop and to test the next generation primitive equation, Terrain-following Ocean Modeling System (TOMS) for high-resolution scientific and operational applications ranging from coastal to basin scales.

OBJECTIVES

The main objective of this new ONR ocean modeling initiative is to evaluate and to include in TOMS current advances in numerical techniques, computational performance, parallelization, nesting, sub-grid scale parameterizations, and data assimilation. Of particular interest is to develop a generalized terrain-following vertical coordinate system and associated accurate, pressure gradient scheme that provides better flexibility when dealing with complex steep and tall topography.

The modular design in TOMS will provide easy coupling with regional operational atmospheric models (like COAMPS), bio-optical models, geochemical models, and sediment transport models.

APPROACH

This a collaborative effort between T. Ezer (Princeton University) and H. Arango (Rutgers University) who maintain, respectively, two of the major community, terrain-following ocean models: Princeton Ocean Model, POM (Blumberg and Mellor, 1987), and Regional Ocean Modeling System, ROMS (Haidvogel et al., 2000). Other modeling groups will joint in the future to contribute in the development and testing of various aspects in TOMS. The role of the PIs is to serve as a linkage between the developers and scientific and operational community of users.

The starting design for TOMS is based on ROMS because of its modular coding and explicit parallel structure conformal to modern computer architectures (both cache-coherent shared-memory and distributed cluster technology). It also offers a stable, accurate and efficient numerics for time-stepping, advection, and pressure gradient discretization algorithms.

WORK COMPLETED

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The project is in the early stages and several planning sessions were carried out by the PIs to coordinate the design and development of TOMS. Evaluation of various numerical algorithms via process oriented test cases were initialized (T. Ezer). Several of the desired basic features in TOMS were coded and tested (H. Arango) in ROMS. The new code include options for the Mellor-Yamada turbulence scheme, passive and active open boundary conditions, rivers, Lagrangian drifters, and advanced data assimilation.

Early in May 2000, A. Moore (U. Colorado) and I visited Scripps to meet with A. Miller, B. Cornuelle, Di Lorenzo, and Neilson and work on ROMS tangent linear and adjoint model development. Earlier attempts to use an automatic adjoint compiler (TAMC) were unsuccessful. It was decided at this meeting to build by hand the tangent linear and adjoint models based on the ideas described in Errico (1997). The workload to build the tangent linear and adjoint codes was equally divided between us and the 2D engine of version were constructed as a prototype.

Additionally, I visited P. Lermusiaux (Harvard) to work on the implementation of his Error Subspace Statistical Estimation (ESSE) data assimilation scheme (Lermusiaux and Robinson, 1999) in ROMS. This scheme was implemented using the shared-memory paradigm of ROMS. An identical twin experiment, using simulated surface currents (CODAR patterns) in our New Jersey coast application, were carried out to debug the implementation of ESSE in ROMS.

RESULTS

We started building the ROMS/TOMS web pages which will provide comprehensive documentation and access to the numerous data and pre- and post-processing software necessary for this project.

IMPACT/APPLICATIONS

This new initiative will provide the ocean modeling community with a freely accessible, well documented, state-of-the-art dynamic and numeric algorithm that can be use as a tool for the study of various physical phenomena.

TRANSITIONS

None.

RELATED PROJECTS

Data assimilation is a very important component to consider in the early stages of TOMS design and development. Under ONR support and with the collaboration of several colleagues in the community, we started the development of the tangent linear and adjoint versions of TOMS/ROMS that can be used to build a general data assimilation platform based on 4D variational data assimilation (4DVAR), Physical Statistical Analysis System (PSAS), representers (Inverse Ocean Modeling System, IOMS), and ensemble prediction via singular vector and stochastic optimals.

This project benefits from the intellectual and technical contributions of colleagues at several institutions (UCLA, SIO, U. Colorado, Harvard, OSU, USGS, ODU, JPL, NIWA, NOAA/FSL, PMEL, etc.

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